U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE
SUBCOMMITTEE ON SPACE AND AERONAUTICS

HEARING CHARTER

Contests and Prizes: How can they help advance space exploration?

July 15, 2004
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

1. Purpose

On Thursday, July 15, 2004, the Subcommittee on Space and Aeronautics of the Committee on Science will hold a hearing to examine whether and how the National Aeronautics and Space Administration (NASA) could use prizes to spur innovation.

NASA has requested permission to begin a small prize program and is seeking legislative authority to run an expanded program. (See details below.)

The type of prizes NASA would offer are known as "inducement prizes" – prizes offered to induce someone to undertake research with a particular goal – as opposed to prizes given for previous achievements (such as the Nobel Prize).

In its report issued last month, the President's Commission on Implementation of United States Exploration Policy (also known as the Aldridge Commission for its chairman, former Undersecretary of Defense Edward "Pete" Aldridge) recommended that NASA offer inducement prizes.

Inducement prizes have also been in the news recently because of the flight of Burt Rutan's SpaceShipOne – the first privately financed flight into space – which was prompted by the X Prize, a $10 million inducement prize for a human suborbital space flight. The X prize is privately funded and administered by a private foundation that was set up for that purpose.

2. Witnesses

Rear Admiral Craig E. Steidle (Ret.) is the Associate Administrator at NASA for Exploration Systems, and oversees the Centennial Challenges program, NASA's program of prize contests.

The Honorable Robert Walker is the Chairman of Wexler & Walker Public Policy Associates and former Chairman of the House Science Committee. He was also a member of the Aldridge Commission.

Dr. Peter Diamandis is the Chairman of the X Prize Foundation, a non-profit organization dedicated to promoting the formation of a space-tourism industry through a $10 million prize.

Dr. Molly Macauley is an economist and Senior Fellow with Resources for the Future. Dr. Macauley's research interests include space economics and policy and the economics of new technologies.

Dr. Douglas Holtz-Eakin is the Director of the Congressional Budget Office.

3. Overarching Questions

The hearing will discuss the following topics:

1. What are the advantages and disadvantages of NASA using prizes to spur innovation?

2. Should prizes be offered for the development of specific, discrete technologies (such as the development of a better astronaut glove), or for large technological feats (such as sending a person into orbit), or should there be a wide range in the size of prizes?

3. To what extent should NASA rely on prize competitions for the development of important new technologies? Should NASA ever rely exclusively on prize competitions for the development of a technology, and if not, how should it determine how to meld competitions with more traditional contracting?

4. How can NASA ensure that technologies resulting from a prize competition are safe, as well as relevant to NASA's objectives?

4. NASA's Proposal for Greater Prize Authority

As part of the Space Exploration Vision that the President announced on January 14, NASA proposed the "Centennial Challenges" program – a set of prize contests for designing particular technologies. NASA requested approval from the Appropriations Committee to begin the Centennial Challenges this fiscal year by transferring $2 million from other programs into the prize effort. The Appropriations Committee denied the request, saying it "was not included as part of the fiscal year 2004 budget submission nor was the initiative approved in the appropriations Act."

This year's program was to award prizes up to $250,000. NASA is also seeking statutory authority to expand the program to $50 million annually and to allow it to award prizes of up to $10 million (and greater amounts, up to $50 million, with the approval of the

NASA Administrator). NASA included the proposal in the reauthorization bill proposal it sent to Congress earlier this year. (See attached list of potential contest topics.)

5. Issues

Could prizes open new pathways to technological innovation for NASA?

Traditionally, NASA has used several tools to spur the development of technologies it needs to carry out its mission. It has awarded grants to universities and other non-profits, it has relied on its own in-house scientists and engineers, and it has drawn up specifications and then awarded contracts for the development or procurement of specific technologies.

Prizes would presumably involve less direction from NASA than would any of the traditional routes. Instead, NASA would offer a prize for the development of a particular technology or achievement, and then would wait to see what contestants produced. Proponents of prizes argue that this would be less costly and less bureaucratic, and might spur more creative thinking. In addition, they argue that inventors and entrepreneurs (as opposed to large aerospace corporations) would be more able to compete than they can under traditional processes, which involve more "red tape."

Some of these benefits are discussed in a 1999 National Academy of Sciences report, "Concerning Federally Sponsored Inducement Prizes in Science and Engineering." The report recommended that Congress encourage federal agencies to experiment more extensively with inducement prize contests in science and technology.

The report noted that traditional peer review processes tend to favor proposals that seem safe over those that may produce surprising and potentially more innovative results. The report also noted that the federal procurement system can be intolerant of risk, and can place costly bureaucratic demands on private-sector contractors.

In summary, the Academy cited prizes as having these benefits:

- the ability to attract a broader spectrum of ideas and participants by reducing the costs and other bureaucratic barriers to participation by individuals or firms;
- the ability of the federal government to shift much of the risk and the financial burden of technology development from the government to the contestants;
- the ability to educate, inspire, and mobilize the public for scientific, technological, and societal objectives.

What are the pitfalls of using prizes to spur technology development?

Prize contests can be less clear-cut than they first appear. Problems can develop in the design of the contest, the selection of a winner, and in the aftermath.

First, NASA would have to be careful in its design of prize contests. The goal for which the prize was being awarded would have to be clearly enough described that contestants (and NASA) had a firm sense of what NASA was seeking and why. On the other hand, too detailed a description by NASA would limit the kinds of ideas that a contest could yield. A very detailed description would not end up being much different than contract specifications.

The selection of a prize winner can also be difficult. Judges need to be open to unexpected ideas. There are historical examples of revolutionary ideas losing prize contests because the judges were not open to unexpected ways of achieving the stated goals. (See below.) On the other hand, NASA would also have to be careful to test prize entries carefully to ensure that there were no safety or other problems that might not be initially apparent.

Finally, in terms of the aftermath, NASA would have to decide how to put a winning idea into actual use. A prize winner might not have the financial wherewithal or even the technical capacity to actually turn their winning idea into a viable product.

The 1999 Academy report suggested these steps to avoid some of the pitfalls:

- Contest rules should be seen as transparent, simple, fair, and unbiased.
- Prizes should be commensurate with the effort required and goals sought.
- Treatment of intellectual property resulting from prize contests should be properly aligned with the objectives and incentive structure of the prize contest.

Finally, it is unclear whether prizes would necessarily be a less costly way of doing business once all the costs NASA would have to incur in running a successful contest are taken into account.

How dependent upon prizes should NASA be for the development of critical technologies?

If a technology is critical to a NASA objective – returning to the moon by 2020, for example – should NASA depend on prizes for the development of relevant technologies? The timing of technology development may be easier to control through traditional means of doing business (although traditional programs have been plagued by delays at times). If NASA wanted to use both prizes and traditional grants and contracts to develop a technology, would those two paths be undertaken simultaneously? Would those with a contract have an unfair advantage? NASA and prize advocates have not yet made clear how they would answer such questions.

What kinds of goals are appropriate for prize contests?

NASA has proposed to use prizes primarily to develop specific, discrete technologies necessary to enable space exploration, such as the development of a better astronaut glove. However, the Aldridge Commission recommended a different type of prize

program that would "accelerate the development of enabling technologies. As an example of a particularly challenging prize concept, $100 million to $1 billion could be offered to the first organization to place humans on the Moon and sustain them for a fixed period before they return to Earth." (p. 33)

The Commission did not elaborate on the idea. It is unclear, for example, what responsibility NASA would have, if any, for ensuring the safety of participants – or even if NASA would have any role at all other than seeing if the expedition succeeded. Nor did the Commission discuss how NASA would evaluate the long-term viability of whatever technology was used on such a mission or how NASA would use any technology that resulted. In one view, NASA would just stand back and offer prizes to create incentives for a wholly private space endeavor. But then would the government take on any manned missions itself?

In general, the more complex the goal of a contest, the more complex NASA's role would likely be. (For example, evaluating a set of technologies to go to the moon is a more demanding undertaking than evaluating an astronaut's glove.) At some point, the complexity might eliminate the advantage of a contest over traditional means of technology development.

6. Background

Recent events

The Defense Advanced Research Projects Agency (DARPA) has been a trailblazer in the use of alternative procurement mechanisms. In the 2000 Defense Authorization Act, Congress gave DARPA authority to offers prizes for "outstanding achievements in basic, advanced, and applied research, technology development, and prototype development" with military applications. DARPA has used that authority to establish its Grand Challenges program, which is offering prizes for a successful field test of autonomous ground vehicles over difficult terrain. In the first such test in the Mojave Desert this March, no one won the $1 million award. The next field test will be held in October 2005 for a $2 million prize.

On June 21, SpaceShipOne, the spacecraft built by Burt Rutan completed the first privately funded manned space flight in history. The flight was a preliminary test in preparation for an attempt Rutan plans to make later this year to win the X-Prize – a $10 million privately-sponsored prize awarded to the first team to launch three humans up 100 kilometers (62 miles) into space, return them safely to Earth, and repeat the launch within two weeks with the same ship. The X-Prize has resulted in increased attention to the role of prizes as an innovative way of attracting non-traditional players to the space industry. (See attached article.)

History

Inducement prizes have been used for centuries.

One well known example is described in the best-selling book Longitude by Dava Sobel. By the 17th century sailors had mastered the ability to determine their exact latitude at sea, but calculating their exact longitude proved to be more complicated. In 1714, through an Act of Parliament, the British Government offered a reward of £20,000 (millions of dollars in today's money) for a "practical and useful" method of accurately determining longitude at sea. The size of the prize reflected both the importance of the issue and the fact that no reliable method was within reach at the time. John Harrison, a working class man with little formal education, eventually solved the problem by developing the first accurate clock that kept time accurately even during a ship's pitching and rolling at sea. However, despite the proven test of his invention at sea, the group administering the prize (the Board of Longitude) refused to award him the prize money – which historians attribute to the Board's domination by astronomers who favored a rival, astronomy-based method of determining longitude. The longitude case illustrates both the ability of a large prize to draw serious proposals and the problems that can arise if the judges have conflicts of interest.

Other prize contests of this type have included privately sponsored prizes for feats of aviation in the early part of the 20th century. In 1919, Raymond Orteig, a New York hotel owner, offered $25,000 to the first aviator to cross the Atlantic from New York to Paris (or vice versa) without a stop. Charles Lindbergh, an unknown airmail pilot, won the Orteig prize on May 28, 1927, 33 1/2 hours after taking off from Roosevelt Field on Long Island. During this period, many skilled, famous aviators died attempting to win the prize. In fact, the study of aviation prizes (and early aviation in general) illustrates that fatalities were highly likely in the attempts at such prizes. This raises the issue of whether fatalities can be expected in the area of prizes associated with manned space flight. If such prizes are conducted and a fatality does occur, it is important to determine if this could impede the development of such contests and stifle the potential innovation that could result from inducement prize programs.

7. Questions for the Witnesses

The witnesses were asked to address the following questions in their testimony:

Questions for Admiral Steidle

1. How does NASA plan to design and administer prizes to induce the greatest possible innovation and advances in space technologies? Why has NASA decided to offer prizes for the development of specific, discrete technologies (such as the development of a better astronaut glove) rather than for large technological feats (such as sending a person into orbit)?

2. How does NASA plan to ensure that technologies resulting from a competition are safe, as well as relevant to NASA's objectives?

3. How involved does NASA plan to be in specifying either the technologies that must be developed (or the goal that must be achieved) to win a prize, overseeing the work of companies competing for prizes, and judging the outcomes of prize competitions? Are there any models NASA is using in designing its prize program?

4. What are the benefits and drawbacks of prizes over other ways the government can spur innovation within the private sector? Are prizes better at drawing participation from non-traditional players in private sector who are not normally involved in government contracts?

Questions for Mr. Walker

1. What are the benefits and drawbacks of prizes over other ways the government can spur innovation within the private sector? Are prizes better at drawing participation from non-traditional players in private sector who are not normally involved in government contracts?

2. To what extent should prizes supplement or replace the existing methods within NASA of developing new technologies, such as contracting, procurement and grants?

3. How can prizes be designed and administered to induce the greatest possible innovation and advances in space technologies? Should they be offered for the development of specific, discrete technologies (such as the development of a better astronaut glove), for large technological feats (such as sending a person into orbit), or should there be a wide range in the sizes of prizes?

4. How involved should NASA itself be in specifying either the technologies that must be developed (or the goal that must be achieved) to win a prize, overseeing the work of companies competing for prizes, and judging the outcomes of prize competitions? Wouldn't NASA's involvement in prizes become more intrusive the larger the technological feat that is being encouraged?

5. How could NASA ensure that technologies resulting from a competition are safe, as well as relevant to NASA's objectives?

Questions for Dr. Diamandis

1. What key ingredients have made the X-Prize so successful in spurring participation by the private sector? To what extent has the X-Prize attracted interest from NASA's traditional contractors to participate in the competition?

2. How can prizes be designed and administered to induce the greatest possible innovation and advances in space technologies? Should they be offered for the development of specific, discrete technologies (such as the development of a

better astronaut glove), for large technological feats (such as sending a person into orbit), or should there be a wide range in the sizes of prizes?

3. Might offering prizes encourage competitors to cut corners when it comes to safety? How could NASA ensure that that technologies resulting from a competition are safe, as well as relevant to NASA's objectives?

4. Should NASA offer prizes or are they best offered only by private organizations such as yours? If you believe NASA should fund prizes, how involved should NASA itself be in specifying either the technologies that must be developed (or the goal that must be achieved) to win a prize, overseeing the work of companies competing for prizes, and judging the outcomes of prize competitions? Wouldn't NASA's involvement in prizes become more intrusive the larger the technological feat that is being encouraged?

5. What needs to happen to transition technologies from a prize winner to a successful ongoing concern? What are the steps the federal government can take to make that transition more likely?

Questions for Dr. Macauley

1. What are the benefits and drawbacks of prizes over other ways the government can spur innovation from the private sector? Are prizes better at drawing participation from non-traditional players in private sector who are not normally involved in government contracts?

2. Some have argued that either the design or administration of certain prizes (e.g. the Longitude Prize) was biased towards a particular technological solution. Are there lessons from the historical record of scientific and technological inducement prizes that could be learned to avoid potentially serious flaws in the design and administration of such programs?

3. How can prizes be designed and administered to induce the greatest possible innovation and advances in space technologies? Should they be offered for the development of specific, discrete technologies (such as the development of a better astronaut glove), for large technological feats (such as sending a person into orbit), or should there be a wide range in the sizes of prizes?

4. Should NASA offer prizes or are they best offered only by private organizations? If you believe NASA should fund prizes, how involved should NASA itself be in specifying either the technologies that must be developed (or the goal that must be achieved) to win a prize, overseeing the work of companies competing for prizes, and judging the outcomes of prize competitions? Wouldn't NASA's involvement in prizes become more intrusive the larger the technological feat that is being encouraged?

5. What needs to happen to transition technologies from a prize winner to a successful ongoing concern? What are the steps the federal government can take to make that transition more likely?

Questions for Dr. Holtz-Eakin

Please discuss your view of prizes with respect to the following issues:

1. How would prizes be scored for budgetary purposes?

2. What are the benefits and drawbacks of prizes over other ways the government can spur innovation from the private sector? Are prizes better at drawing participation from non-traditional players in private sector who are not normally involved in government contracts?

3. How can prizes be designed and administered to induce the greatest possible innovation and advances in space technologies? Should they be offered for the development of specific, discrete technologies (such as the development of a better astronaut glove), for large technological feats (such as sending a person into orbit), or should there be a wide range in the sizes of prizes? Wouldn't NASA's involvement in prizes become more intrusive the larger the technological feat that is being encouraged?

4. What is the experience private sector experience in the area of prizes, including the issues of risk and intellectual property?

5. What is the experience of the federal government in the area of inducement prizes? If Congress were to consider a program of inducement prizes for NASA, what issues does this bring up, and what are the options, for either the authorization or appropriations process?

6. What needs to happen to transition technologies from a prize winner to a successful ongoing concern? What are the steps the federal government can take to make that transition more likely?

8. Attachments

New York Times article, "Into Space, Without NASA" (August 26, 2003).

Summary of candidates for NASA Centennial Challenges prizes.